PATENT ABSTRACTS OF JAPAN

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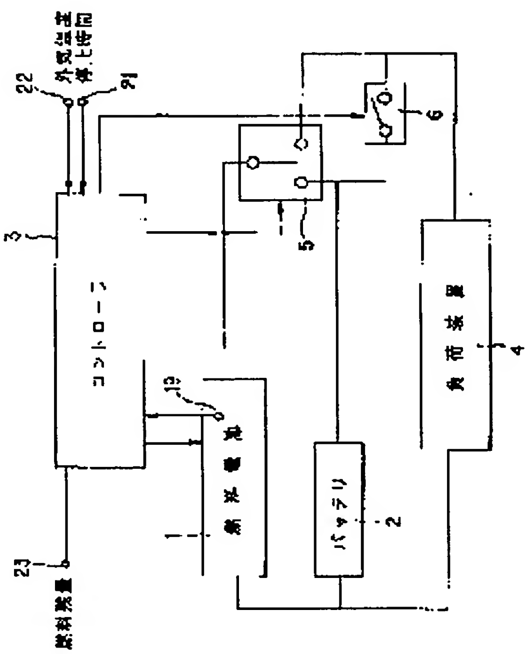
(54) FUEL CELL SYSTEM AND ITS STOP METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent freezing of a fuel cell during system stop without heating or restarting the fuel cell.

SOLUTION: When a fuel cell system is stopped, a controller 3 restricts the flow rate of a coolant to the fuel cell 1 to lower the cooling of the fuel cell 1, continues the operation of the fuel cell 1, and conducts temperature raising to raise the temperature of the fuel cell by utilizing the heat generated in the electrochemical reaction of the fuel cell 1, and stops the operation of the fuel cell 1 after the temperature of the fuel cell 1 is raised to the specified high temperature.



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CLAIMS

[Claim(s)]
[Claim 1] The fuel cell which generates electricity according to electrochemical reaction, and a cooling means to cool generation of heat by said electrochemical reaction, A temperature up processing means to carry out continuation operation of said fuel cell while reducing the cooling engine performance of said cooling means, and to raise the temperature of said fuel cell using generation of heat by said electrochemical reaction in case a system is suspended, The fuel cell system characterized by having the means for stopping which stops operation of said fuel cell after the temperature of said fuel cell rises.
[Claim 2] It is the fuel cell system according to claim 1 characterized by stopping said temperature up processing when high temperature have a means to detect the temperature of said fuel cell, and predetermined [means for stopping / said] in the temperature of said fuel cell is reached.
[Claim 3] Said means for stopping is a fuel cell system according to claim 1 characterized by stopping said temperature up processing when the temperature of said fuel cell is judged to have reached predetermined high temperature from the duration of said temperature up processing.
[Claim 4] It is the fuel cell system according to claim 2 or 3 which is equipped with a means to detect the OAT of said fuel cell, and is characterized by setting up said predetermined high temperature so highly that an OAT becoming low.
[Claim 5] Said temperature up processing means is the fuel cell system of any one publication of four from claim 2 characterized by not performing said temperature up processing when temperature of said fuel cell cannot be raised to said predetermined high temperature, even if it uses all remaining fuel.
[Claim 6] it be the fuel cell system of any one publication of five from claim 1 which be equip with a means predict time amount until the account fuel cell of system stop back to front freeze based on a means input a stop time until it be start next after a halt of a system , and fuel cell temperature and an OAT , and be characterize by not to perform said temperature up processing when said temperature up processing means be shorter than the time amount to freezing said stop time be predicted to be .
[Claim 7] The fuel cell system of any one publication of six from claim 1 characterized by charging the power which is equipped with a rechargeable battery with a charge function, and said fuel cell generates by said temperature up processing at said rechargeable battery.
[Claim 8] The fuel cell system of any one publication of seven from claim 1 to which said fuel cell is characterized by consisting of a polymer electrolyte fuel cell cel or a phosphoric acid fuel cell cel.
[Claim 9] The halt approach of the fuel cell system characterized by what operation of said fuel cell stops for after carrying out continuation operation of said fuel cell, raising the temperature of said fuel cell using generation of heat by said electrochemical reaction and the temperature of said fuel cell rising, while reducing the cooling engine performance of the cooling means of said fuel cell in the halt approach of the fuel cell system equipped with the fuel cell which generates electricity according to electrochemical reaction in case a system suspends.

[Translation done.]

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* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to a fuel cell system and its halt approach.
[0002]
[Description of the Prior Art] Like a polymer electrolyte fuel cell, in order to operate a fuel cell, a thing to be humidified [of a fuel cell] is in the fuel cell which generates electricity using the energy produced from the chemical reaction of hydrogen and oxygen. Moreover, since the fuel cell itself is accompanied by generation of heat at the time of a generation of electrical energy, the cooling system which cools a fuel cell with cooling water etc. is needed.
[0003] If the fuel cell system equipped with such a fuel cell is left below the freezing point in a idle state, the moisture and cooling water in a cell will be frozen, and since it becomes the cause of failure or becomes the trouble at the time of making it reboot, the method of preventing freezing of a fuel cell is proposed variously (JP,7-169475,A, JP,11-214025,A, etc.).
[0004]
[Problem(s) to be Solved by the Invention] However, it is not not much desirable from viewpoints, such as safety, that each conventional approach heats a fuel cell from the outside by a burner etc. when the case where fuel cell temperature falls, and an OAT fall, or it reboots a fuel cell automatically, and these processings are independently performed automatically with an operator's intention during a system stop.
[0005] This invention is made in view of the starting technical technical problem, and it aims at preventing freezing of a fuel cell, without performing heating and a reboot of a fuel cell during the above-mentioned system stop.
[0006]
[Means for Solving the Problem] The fuel cell to which the 1st invention generates electricity according to electrochemical reaction in a fuel cell system, A cooling means to cool generation of heat by said electrochemical reaction, and when a system is suspended, A temperature up processing means to carry out continuation operation of said fuel cell while reducing the cooling engine performance of said cooling means, and to raise the temperature of said fuel cell using generation of heat by said electrochemical reaction, After the temperature of said fuel cell rises, it is characterized by having the means for stopping which stops operation of said fuel cell.
[0007] In the 1st invention, 2nd invention is characterized by stopping said temperature up processing, when it has a means to detect the temperature of said fuel cell and high temperature predetermined [means for stopping / said] in the temperature of said fuel cell is reached.
[0008] 3rd invention is characterized by stopping said temperature up processing, when the means for stopping in the 1st invention is judged that the temperature of said fuel cell reached predetermined high temperature from the duration of said temperature up processing.
[0009] The 4th invention is equipped with a means to detect the OAT of said fuel cell, in the 2nd or 3rd invention, and it is characterized by setting up said predetermined high temperature so highly that an OAT becoming low.
[0010] 5th invention is characterized by not performing said temperature up processing, when it cannot raise temperature of said fuel cell to said predetermined high temperature, even if the temperature up processing means in the 2nd to 4th invention uses all remaining fuel.
[0011] The 6th invention is equipped with a means predict time amount until the account fuel cell of system stop back to front freezes based on a means input a stop time until it is started next after a halt of a system in the 1st to 5th invention , and fuel cell temperature and an OAT , and when said temperature up processing

means is short than the time amount to freezing said stop time was predicted to be , it is characterized by not to perform said temperature up processing .
[0012] In the 1st to 6th invention, the 7th invention is equipped with a rechargeable battery with a charge function, and is characterized by charging the power which said fuel cell generates by said temperature up processing at said rechargeable battery.
[0013] 8th invention is characterized by the fuel cell in the 1st to 7th invention consisting of a polymer electrolyte fuel cell cel or a phosphoric acid fuel cell cel.
[0014] In case the 9th invention suspends a system, while reducing the cooling engine performance of the cooling means of said fuel cell, after carrying out continuation operation of said fuel cell, raising the temperature of said fuel cell using generation of heat by said electrochemical reaction and the temperature of said fuel cell rising, it is characterized by to stop operation of said fuel cell in the halt approach of the fuel cell system equipped with the fuel cell which generates electricity according to electrochemical reaction.
[0015]
[Function and Effect] Therefore, in the fuel cell system concerning this invention, in case a system is stopped, while reducing the cooling engine performance of a fuel cell, a fuel cell carries out continuation operation, and the temperature of a fuel cell is raised using the heat of reaction of the electrochemical reaction performed within a fuel cell. And a system is suspended after carrying out the temperature up of the fuel cell (1st and 9th invention). Thus, by raising the temperature of a fuel cell beforehand at the time of a system stop, as time amount until a fuel cell causes freezing at the time of a system stop can be extended and it is not cooled to the temperature which will cause freezing by the time of a reboot, freezing of a fuel cell can be prevented.
[0016] Since the temperature up of a fuel cell is performed by generation of heat of the cell itself, the temperature of a fuel cell can be efficiently raised with small fuel consumption and only a fuel cell is heated, it is avoidable that parts other than a fuel cell and the part it is not desirable applying heat especially are heated. Moreover, since heating apparatus does not operate automatically during a system stop or a fuel cell system does not reboot automatically, the situation where these actuation is performed regardless of an operator's intention during a system stop is avoidable.
[0017] Here, if it is made to perform temperature up processing until it carries out the monitor of the temperature of a fuel cell and the temperature of a fuel cell reaches predetermined high temperature, the temperature up of a fuel cell can be performed certainly (2nd invention). It may be made for whether the temperature of a fuel cell reached predetermined high temperature from the duration of temperature up processing to judge instead of carrying out the monitor of the temperature of a fuel cell (3rd invention), and according to this, there is an advantage that the sensor which detects the temperature of a fuel cell becomes unnecessary.
[0018] Since the descent degree of the temperature of a fuel cell is also so strong that an OAT is low at this time, if the above-mentioned predetermined high temperature is more highly set up so that an OAT is low, an antifreeze effect can be heightened more (4th invention). This can also be preventing temperature up processing being continued beyond the need, when an OAT is comparatively high, it can hold down excessive fuel consumption, and can perform temperature up processing more efficiently.
[0019] Moreover, since cell temperature cannot be raised to temperature required for anti-freeze even if it performs temperature up processing when the fuel required to raise cell temperature to the above-mentioned predetermined high temperature does not remain, in such a case, it is made not to perform temperature up processing (5th invention). By this, it can prevent that useless temperature up processing is performed, and fuel consumption can be stopped. However, since freezing of a fuel cell may take place in this case, when a fuel cell freezes, it will be necessary to heat a fuel cell from the outside at a burner, a heater, etc.
[0020] Moreover, the consumption of a fuel can be further stopped because the temperature of a fuel cell may not descend to freezing temperature and it is made not to perform the above-mentioned temperature up processing in such a case, even if it will not perform the above-mentioned temperature up processing, if the stop time of a system is short (6th invention).
[0021] Moreover, if the power generated by the above-mentioned temperature up processing is stored in a dc-battery, a part of energy which temperature up processing took can be collected, and a deployment of energy can be aimed at (7th invention).
[0022] Especially these invention is effective when becoming failure of a fuel cell and the cause of a poor reboot, if a fuel cell carries out the need of the humidification and freezing of moisture takes place, when a fuel cell consists of a polymer electrolyte fuel cell cel or a phosphoric acid fuel cell cel (8th invention).
[0023]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on an accompanying drawing.
[0024] Drawing 1 is the schematic diagram of the fuel cell system concerning this invention. The fuel cell system is using as the main components a fuel cell 1, the controller 3 which performs that control, the dc-battery 2 which charges the power generated at the time of temperature up operation, and switches 5 and 6, and load equipment 4 is connected to this fuel cell system.
[0025] A fuel cell 1 consists of polymer electrolyte fuel cell cels (or phosphoric acid fuel cell cel), and is a fuel cell to be humidified working. A controller 3 consists of CPU, RAM, a ROM, input/output port, etc., and performs temperature up processing of the fuel cell 1 at the time of the system stop explained below etc.

[0026] Load equipment 4 is a motor which receives the power from a fuel cell 1 and generates driving force. The driving force of a motor is told to the front wheel and/or rear wheel of a car through the axle in the car which carries a fuel cell, and turns into driving force which makes it run a car.
[0027] A fuel cell 1 is connectable with load equipment 4 and a dc-battery 2 through switches 5 and 6. During system operation, load equipment 4 is connected with a fuel cell 1, and a dc-battery 2 is connected with a fuel cell 1 during the temperature up processing performed in case a system is stopped. A dc-battery 2 is the rechargeable battery of a lead accumulator, a nickel-cadmium battery, a lithium cell, a nickel hydoride battery, etc. which can be charged.
[0028] Drawing 2 shows the outline configuration of a fuel cell 1. The cell proper 11 of a fuel cell 1 has the stack structure which carried out two or more laminatings of the single cel which is a configuration unit. Fuel gas, such as hydrogen, is supplied to a negative-electrode side, oxidant gas, such as oxygen, is supplied to a positive-electrode side, and this cell proper 11 acquires electromotive force by the following chemical reactions.
[0029]
H2 ->2H++2e- ... (1)
1/2O2+2H++2e-->H2O ... (2)
H2+1/2O2->H2O ... (3)
A formula (1) is anode electrode reaction and a formula (2) is cathode electrode reaction. The formula (3) shows the chemical reaction which occurs by the whole cell.
[0030] In addition to this, a fuel cell 1 is equipped with the piping 12 which supplies fuel gas, the piping 13 which supplies oxidant gas, the piping 14 which supplies a cooling agent (cooling water), the heat exchanger 16 which performs heat exchange between a cooling agent and the open air, the cooling agent tank 17, the bulb 15 which adjusts the flow rate of a cooling agent and the pump 18 made to circulate through a cooling agent, the temperature sensor 19 which detects the temperature of a cell proper 11, and the piping selection section 20.
[0031] In case the above-mentioned fuel cell system is stopped, while reducing the cooling function of a cell proper 11, the above-mentioned electrochemical reaction is made to continue, and the temperature up of the cell proper 11 is carried out by generation of heat of cell-proper 11 self. Since it has the thermal resistance to a certain amount of temperature, such as an electrolyte membrane, a gaseous diffusion layer, and a separator, if a part of gas-seal quality of the materials are removed among the components of a stack used with the polymer electrolyte fuel cell now, a cell proper 11 can be heated to heat-resistant predetermined temperature. [0032] Although the heat exchanger 16 has the function which lowers the temperature of the cooling agent which has passed the cooling agent process line 14, when carrying out the temperature up of the cell proper 11, a cooling function can be conversely reduced by reducing the circulation velocity of a cooling agent. Furthermore, it can also change into the condition of not letting a cooling agent pass to a heat exchanger 16 by the piping selection section 20, a cooling function falls further in this case, and temperature up descent of a cell proper 11 is raised. In addition, you may make it attach moderate gas purge opening in a cell proper 11 in consideration of a steam collecting that temperature up temperature becomes high within a cell proper 11.
[0033] Next, it explains, referring to the flow chart shown in drawing 3 about the temperature up processing of a fuel cell 1 performed at the time of a halt of the above-mentioned fuel cell system. This flow is performed in a controller 3, in case a system is stopped.
[0034] In case a system is stopped, OAT Tout first detected by the cel temperature (following, "cell temperature") Tcell and the temperature sensor 22 of the cell proper 11 detected by the temperature sensor 19 is read (step S1). And the stop time te which the operator inputted through the input unit 21 connected to the controller 3 predicts is read (step S2), and it is judged based on this and OAT Tout whether temperature

up actuation of a fuel cell 1 is performed.
[0035] Based on OAT Tout and the cell temperature Tcell, the time amount (the following, "cooldown delay") tc until a fuel cell 1 is cooled by natural heat dissipation to Tlow (for example, 0 degree C) whenever [predetermined low-temperature] is specifically predicted (step S3), and the existence of the need for temperature up actuation is judged by whether the stop time te of a system is longer than this cooldown delay tc (step S4).
[0036] Since it does not fall to Tlow next time whenever [predetermined / above-mentioned / in cell temperature Tcell at time of starting low-temperature] even if it does not perform temperature up processing when the stop time te of a system is shorter than the time amount tc to cooling of a cell, a fuel cell is stopped, without performing temperature up processing (step S4 -> step S12). It can prevent that unnecessary temperature up processing is performed by this, and fuel consumption can be stopped. However, even if it is this case, with reference to the temperature-change hysteresis of OAT Tout etc., it may be made to perform a moderate temperature up. For example, OAT Tout is in a fall inclination, and the cell temperature Tcell judges that it may fall to Tlow whenever [above-mentioned low-temperature / predetermined], and may be made to perform temperature up processing.
[0037] When a stop time te is longer than a cooldown delay tc, the temperature up of the fuel cell 1 is carried out to predetermined high temperature T* at the time of a halt, and it is made not to fall to Tlow on the other hand whenever [predetermined low-temperature / from which the temperature of a fuel cell 1 will start freezing by the time of a reboot].
[0038] Here, predetermined high temperature T* is set as such high temperature that the system stop time amount te becomes long, so that OAT Tout becomes low, since the descent degree of the cell temperature Tcell becomes large, so that OAT Tout is low, and so that the system stop time amount te becomes long. Moreover, you may make it change predetermined high temperature T* suitably by whether there is any kana in which OAT Tout becomes below the freezing point.
[0039] However, since the stop time te is too long compared with a cooldown delay tc even if it is the case that the stop time te of a system is long, Even if it uses remaining fuel F1 altogether, when a temperature up cannot be carried out to temperature T* required to prevent freezing, or [namely, / making temperature up processing small since the temperature up processing becomes useless after all even if it performs temperature up processing when there is more fuel quantity F2 required to carry out the temperature up of the cell temperature Tcell to predetermined high temperature T* than remaining fuel F1] -- or it is made not to carry out at all. The need fuel quantity F2 can be calculated based on temperature T*, the present cell temperature Tcell, etc.
[0040] or [furthermore, / making temperature up actuation small since it becomes the cause which causes functional degradation of a fuel cell 1 also when it is set as high temperature (T*>Tuplim) so that predetermined high temperature T* affects a cell configuration member] -- or it is made not to carry out at all (S8 from step S5 -> step S12). The upper limit temperature Tuplim can be beforehand included in a control program, and this can set it as arbitration in the range which does not affect degradation of the configuration member of a fuel cell 1.
[0041] In the reforming mold fuel cell system which supplies the hydrogen which reforms hydrocarbon fuels, such as a quantity to be stored of hydrogen, and a methanol, in the direct hydrogen mold fuel cell system which supplies the hydrogen stored to a fuel cell directly, and is obtained to a fuel cell, remaining fuel F1 is a residue of a hydrocarbon fuel, and is detected by the remaining fuel sensor 23 attached in the fuel tank etc. Remaining fuel F1 calculates the fuel consumption from the time of full, and you may make it calculate it by subtracting fuel consumption from maximum capacity, such as a fuel tank.
[0042] For a long time [the stop time te of a system] than a cooldown delay tc, when temperature up processing of the possible range is needed with fuel quantity F1 (F1> F2), temperature up processing is performed until the temperature of a fuel cell 1 rises to predetermined temperature T* (from step S9 to S11). It is performed by continuing a fuel cell 1 and operating (a fuel being supplied) while temperature up processing extracts a bulb 15, suspends reduction or a pump 18 for the flow rate of the cooling agent to a fuel cell 1 and stops supply of the cooling agent to a fuel cell 1.
[0043] Furthermore, when it is made for a cooling agent not to circulate to a heat exchanger 16 by the piping selection section 20 when predetermined temperature T* needs to heighten the temperature up effectiveness highly, and it is necessary to carry out the temperature up of the cell temperature Tcell beyond the boiling point temperature of a cooling agent, after discharging a cooling agent from the inside of a fuel cell 1, a fuel cell 1 is operated, and it may be made to perform the temperature up of a fuel cell 1.
[0044] If such temperature up processing is continued until the cell temperature Tcell detected by the

temperature sensor 19 reaches predetermined high temperature T*, and predetermined temperature T* is reached, the fuel gas to a fuel cell 1 and supply of oxidant gas will be suspended, and operation of a fuel cell 1 will be suspended (step S12).

[0045] In addition, until the cell temperature Tcell reaches predetermined temperature T* here, although temperature up processing is continued The time amount taken to heat a fuel cell 1 from a certain temperature to predetermined high temperature T* beforehand in the memory of a controller 3 is memorized in forms, such as a table and a map. When the predetermined time from which the elapsed time from the time of temperature up processing initiation is acquired with reference to these tables or a map is reached, you may make it judge that the cell temperature Tcell reached predetermined temperature T*.

[0046] Moreover, since the power which the fuel cell 1 generated with temperature up processing is stored in a dc-battery 2, the temperature up of the fuel cell 1 with few energy losses is realized. The power stored in the dc-battery 2 can be used if needed as power required at the time of a system reboot, or power required at the time of a system stop after that.

[0047] Drawing 4 shows the result of a temperature-reduction experiment of the fuel cell which checks the effectiveness of the above-mentioned temperature up processing by this invention and which went to accumulate. The experiment was in the thermostatic chamber which fixed temperature (-10 degrees C), and it was conducted by insulating also for various piping in order to prepare fuel cell 10 cel which insulated the perimeter with the heat insulator and to avoid heat dissipation if possible.

[0048] After making it operate continuously until a drawing solid line corresponds when not applying this invention, and cel temperature and the cooling agent temperature through which it circulates are fixed (333K) by current density 1 A/cm2, a fuel cell is stopped and change of the cell temperature at the time of leaving it as it is after that is shown. On the other hand, a drawing destructive line corresponds, when this invention is applied, the circulation velocity of a cooling agent is controlled, the temperature up of the fuel cell is carried out, and when cel temperature amounts to 368K, change of the cell temperature when stopping and leaving a fuel cell is shown. In addition, in any case, the time of neglect initiation is made into time amount 0.

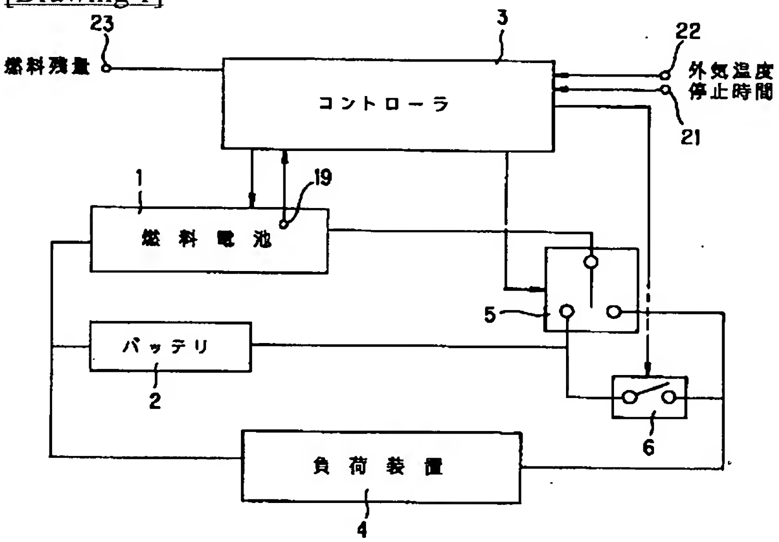
[0049] If cell temperature at the time of stopping a fuel cell is made high as shown in this, the temperature of the fuel cell after a halt is also maintained highly, and time amount until freezing of a fuel cell takes place can be delayed as the drawing Nakaya mark A shows. In this invention, since the temperature up of the fuel cell is enough carried out according to an OAT etc. at the time of a halt, before a fuel cell freezes, a fuel cell can be rebooted, and freezing of a fuel cell can be prevented.

[0050] In addition, it is possible to make time amount until it reaches freezing temperature by performing heat insulation processing suitably between a fuel cell and the open air like this example extend further.

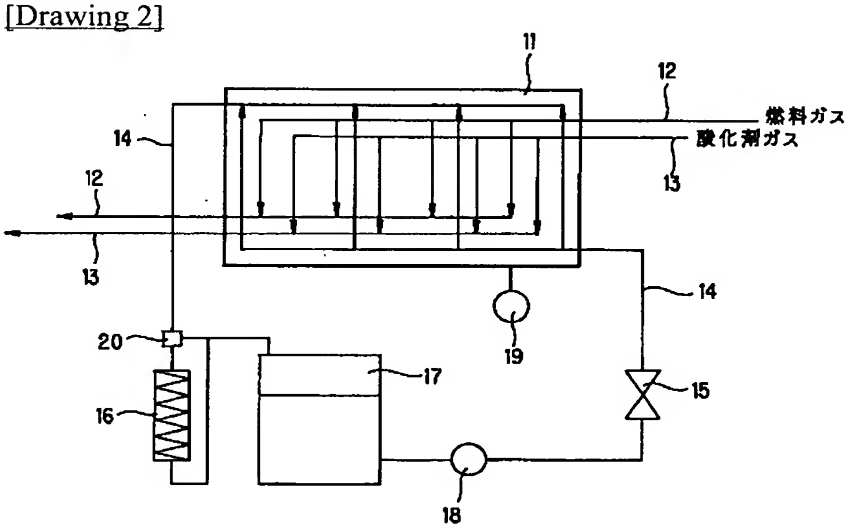
[Translation done.]

DRAWINGS

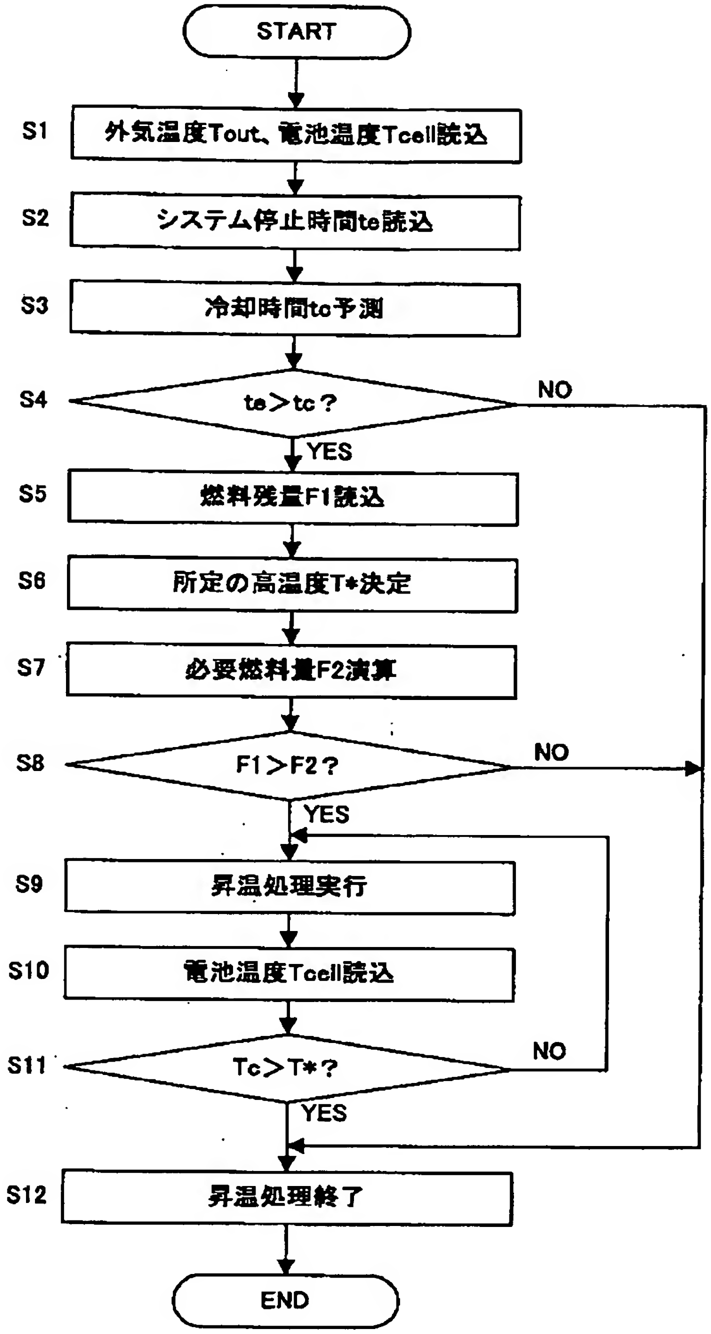
[Drawing 1]



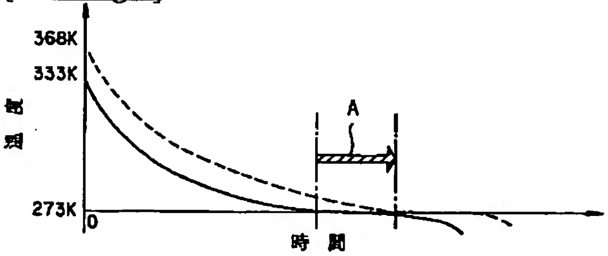
[Drawing 2]



[Drawing 3]


START
S1
外気温度Tout、電池温度Tcell読込
S2
システム停止時間te読込
S3
冷却時間tc予測
S4
te＞tc？
NO
YES
S5
燃料残量F1読込
S6
所定の高温度T*決定
S7
必要燃料量F2演算
S8
F1＞F2？
NO
YES
S9
昇温処理実行
S10
電池温度Tcell読込
S11
Tc＞T*？
NO
YES
S12
昇温処理終了
END

[Drawing 4]


368K
333K
273K
0
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時 間

[Translation done.]